

§23. On the Performance of Retrieving Similar Waveforms

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An experiment of the fusion phenomena produces a lot of sets of time-varying values. As a set of the values forms a waveform, a lot of waveforms are produced. If the waveforms similar to the specified one can be obtained by using a computer, the burden of researchers in searching similar waveforms will be extremely reduced. Finding the similar waveforms may bring us a new breakthrough. We have addressed the issue on this kind of retrieval in [1,2]. The method based on the Fourier Transformation has been proposed [1]. It has been shown that waveforms having slightly different wave lengths can also be retrieved by using the method [2]. However, it takes very long time to retrieve similar waveforms.

This paper studies on the retrieval performance of similar waveforms. The end of this paper is proposing a search method having better retrieval performance.

The following is the major result of our paper [2]. When the signal $g(t)$ is described as $g(t) = f(t/(1 + \alpha))$, where $\alpha \ll 1$, the Fourier Transformation $G(\omega)$ of $g(t)$ can be approximated as $G(\omega) \approx F(\omega)e^{-j\omega\alpha t}$, where $F(\omega)$ is the Fourier Transformation of signal $f(t)$.

The straightforward way of retrieving similar waveforms is to use the proposed waveform retrieval method [1] repeatedly with slightly different α . This method is called the *angle method*. The less $\Delta\alpha$ is, the better precision can be obtained. However, the less $\Delta\alpha$ is, the more repetitions are required. This results in the bad retrieval performance.

Another method obtains a large set of waveforms at first. The waveforms obtained are next examined to be fitted to a waveform having a different wave length. This method is called the *heavy-eater method*. The wider the area is searched, more time for retrieval is required, more waveforms are obtained, and more time has to be wasted at the fitting examination phase.

The third method tries to narrow the search area in the heavy-eater method. This method uses several narrow areas rather than a wide area in the retrieval. As the fitting examination is a kind of rotation, it is considered that the candidates reside on an arc between some angles. The search area can be limited to the portions holding the arc. Figure 1 shows an illustrative explanation in a complex plane. The original search area is drawn with dashed line. The partitioned search area is drawn with the thick line. The arc is the trace of the rotation. This method is called

the *diagonal method*. This method may narrow the total search area, and reduce the number of candidate waveforms.

These three kinds of methods are evaluated. The effect on the performance of the interval of angles ($\Delta\alpha$) is measured. The evaluation uses 1000 Bolometer waveforms. The result is shown in Fig. 2. In Fig. 2, for example, diag3 means the diagonal method with three partitions. The result shows that the diagonal method with five partitions gets the best. Partitioning search area could work well in the retrieval. In this evaluation, the performance of diag3 is almost equal to that of diag5. This may be caused by the trade-off of the number of candidate waveforms and the number of repetitions.

The waveforms treated are of integral forms. Retrieving similar waveforms of vibration forms is the topic of future research.

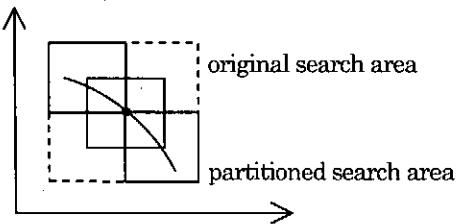


Fig. 1. Partitions of search area.

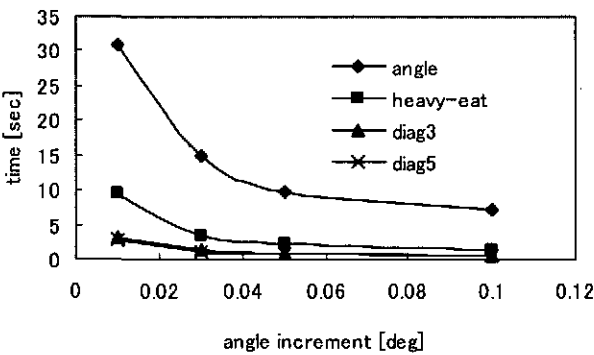


Fig. 2. Retrieval performance evaluation.

Reference

- 1) Hochin, T., Nakanishi H. and Kojima M.: On the Construction of Databases of Experiment Data, Annual Report of National Institute for Fusion Science April 2001-March 2002, (2002) 167.
- 2) Hochin, T., Nakanishi H. and Kojima M.: A Method of Retrieving Similar Waveformms, Annual Report of National Institute for Fusion Science April 2002-March 2003, (2003).